FIG. 1

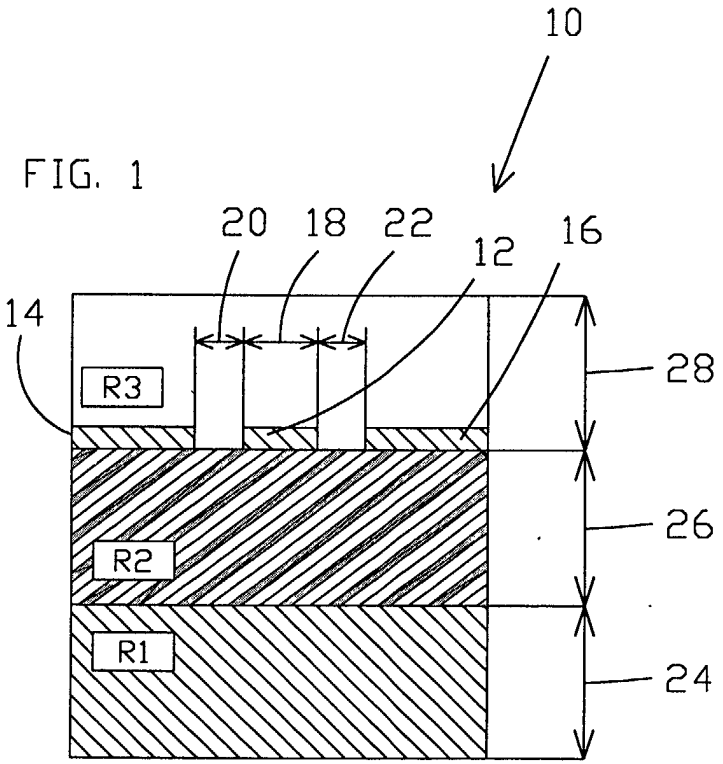

FIG. 2

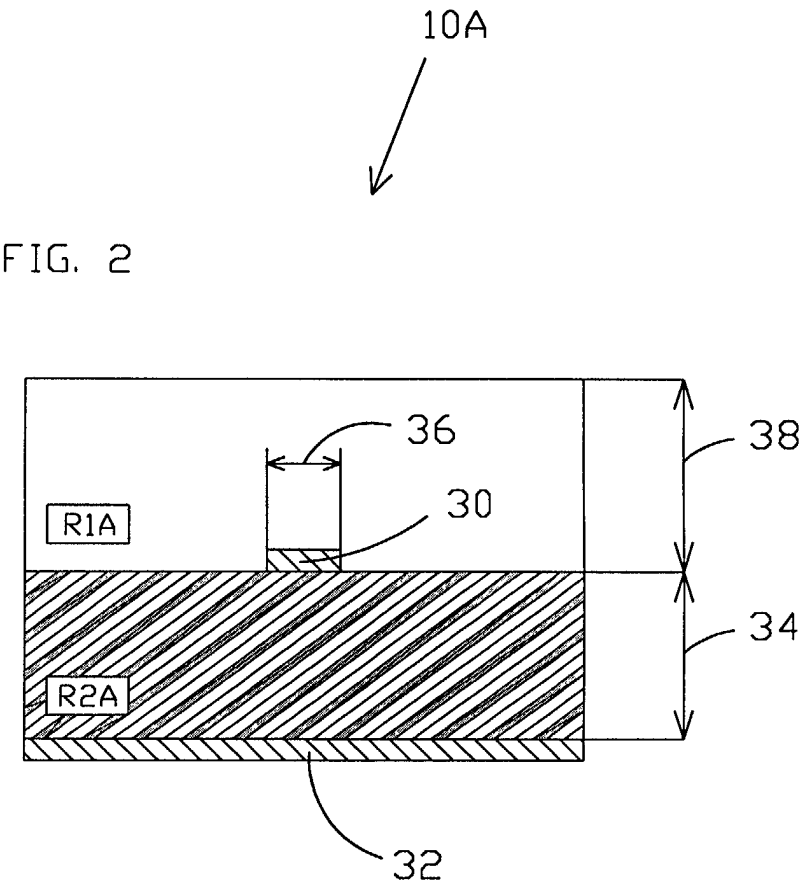

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FIG. 3

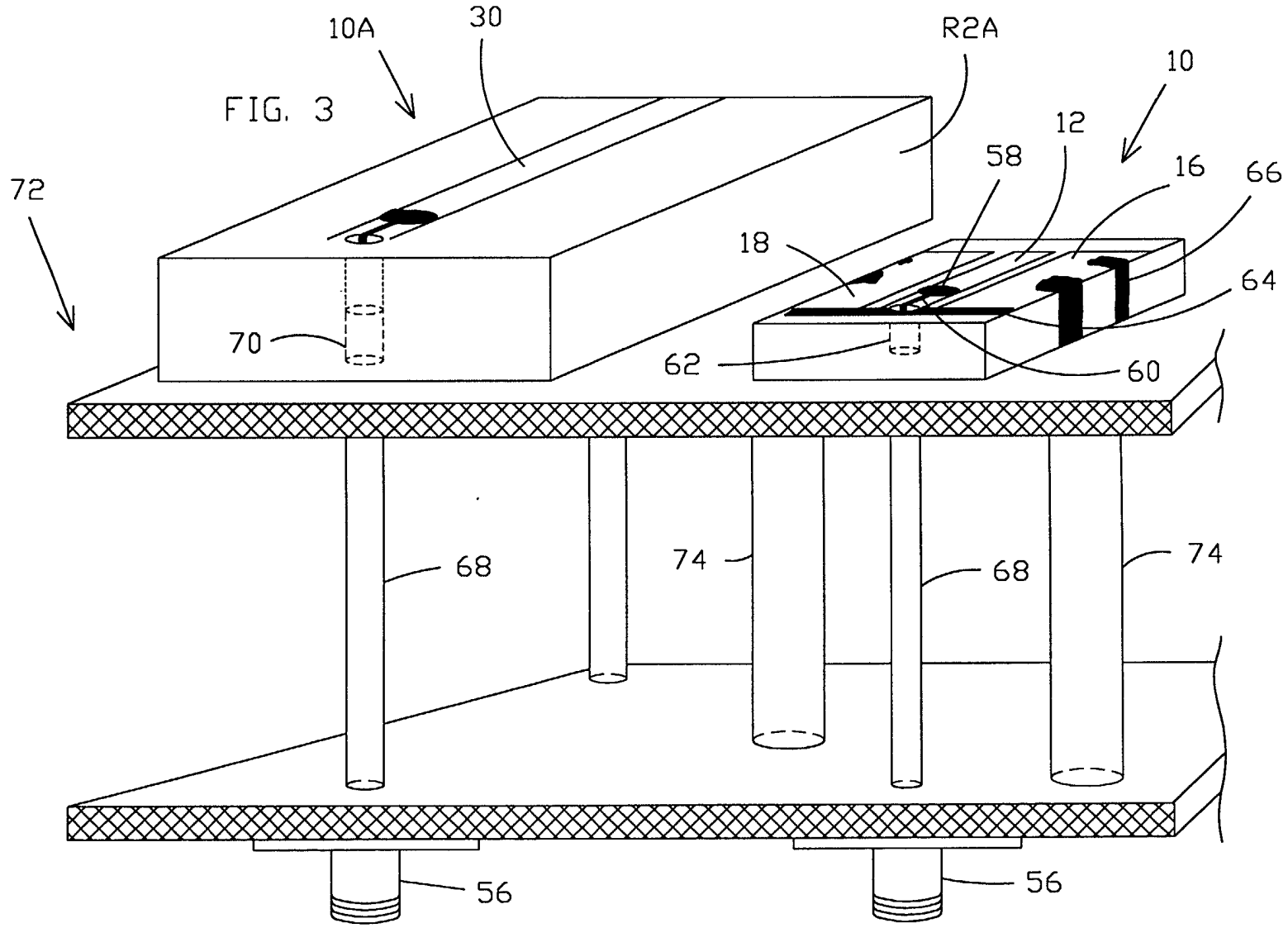

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FIG. 4

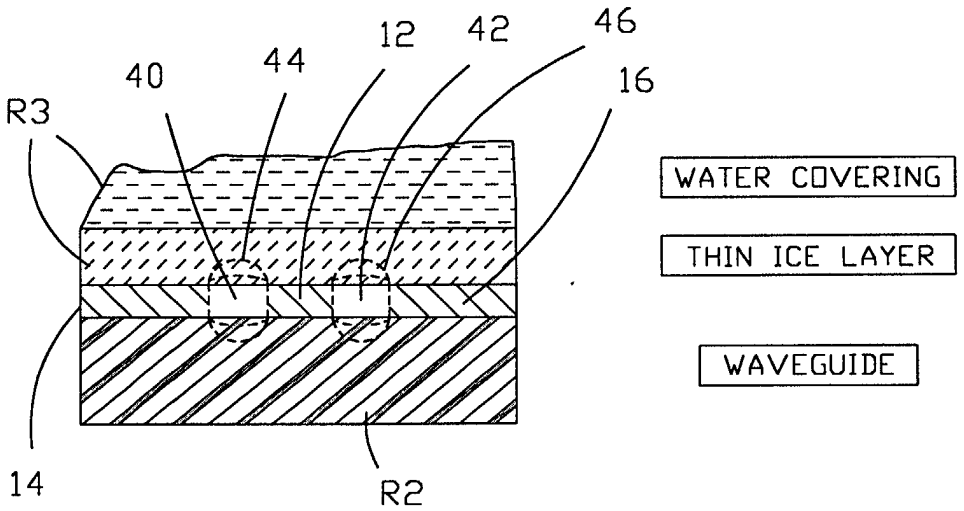


FIG. 5

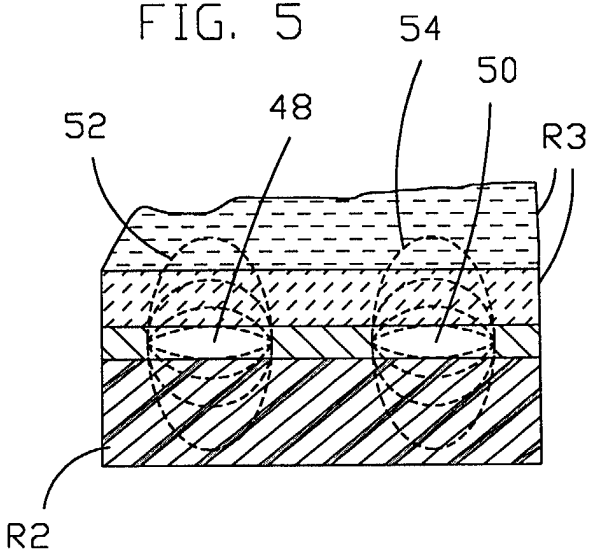


FIG. 6

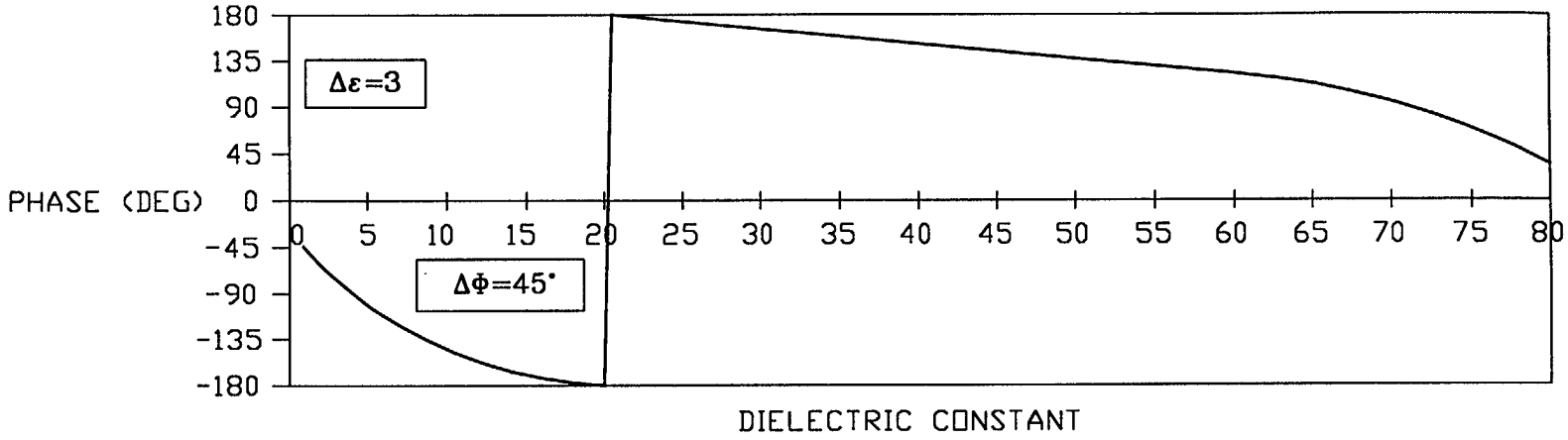

180
135
90
45
0
-45
-90
-135
-180
PHASE (DEG)
Δε=3
ΔΦ=45°
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80
DIELECTRIC CONSTANT

FIG. 7

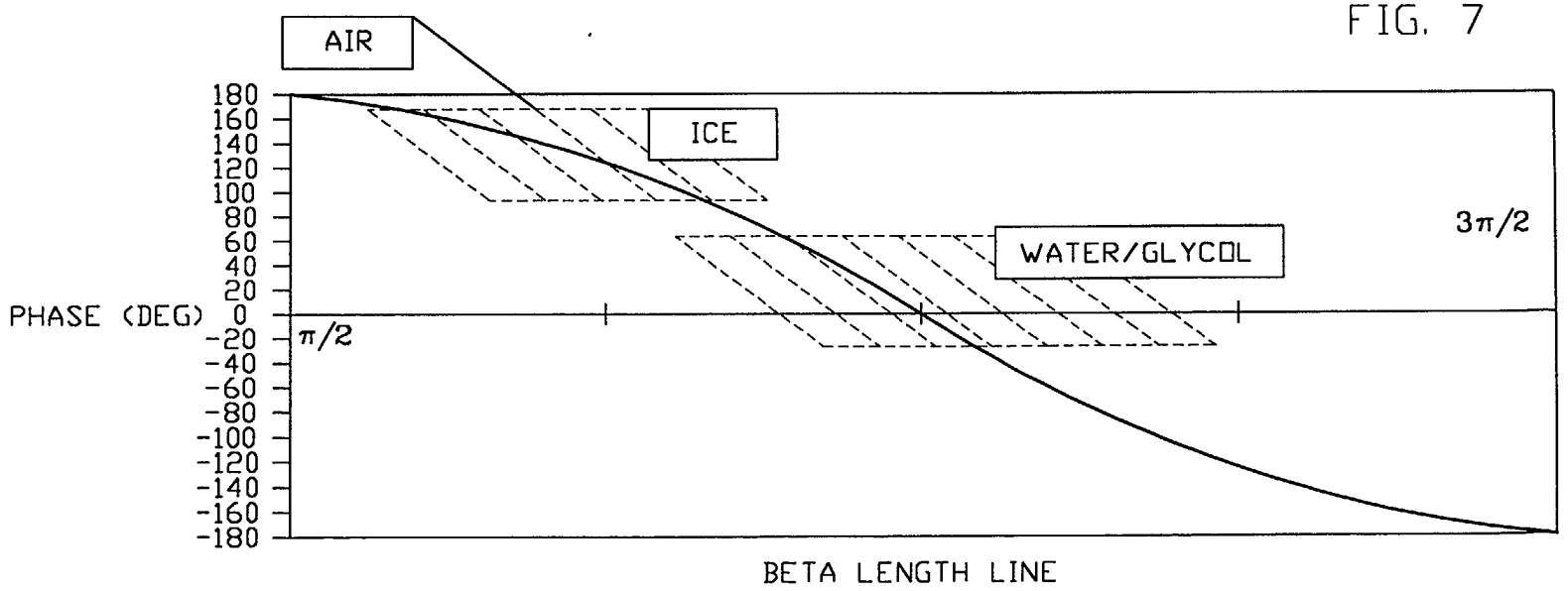

AIR
ICE
WATER/GLYCOL
3π/2
π/2
180
160
140
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
PHASE (DEG)
BETA LENGTH LINE

FIG. 8

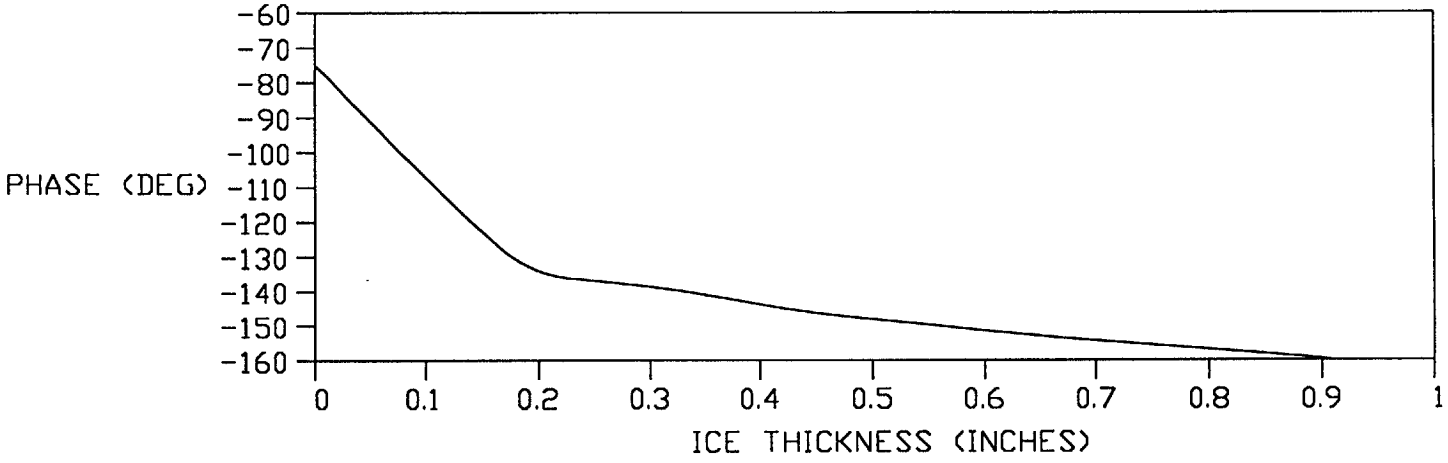

PHASE (DEG)
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
ICE THICKNESS (INCHES)

FIG. 9

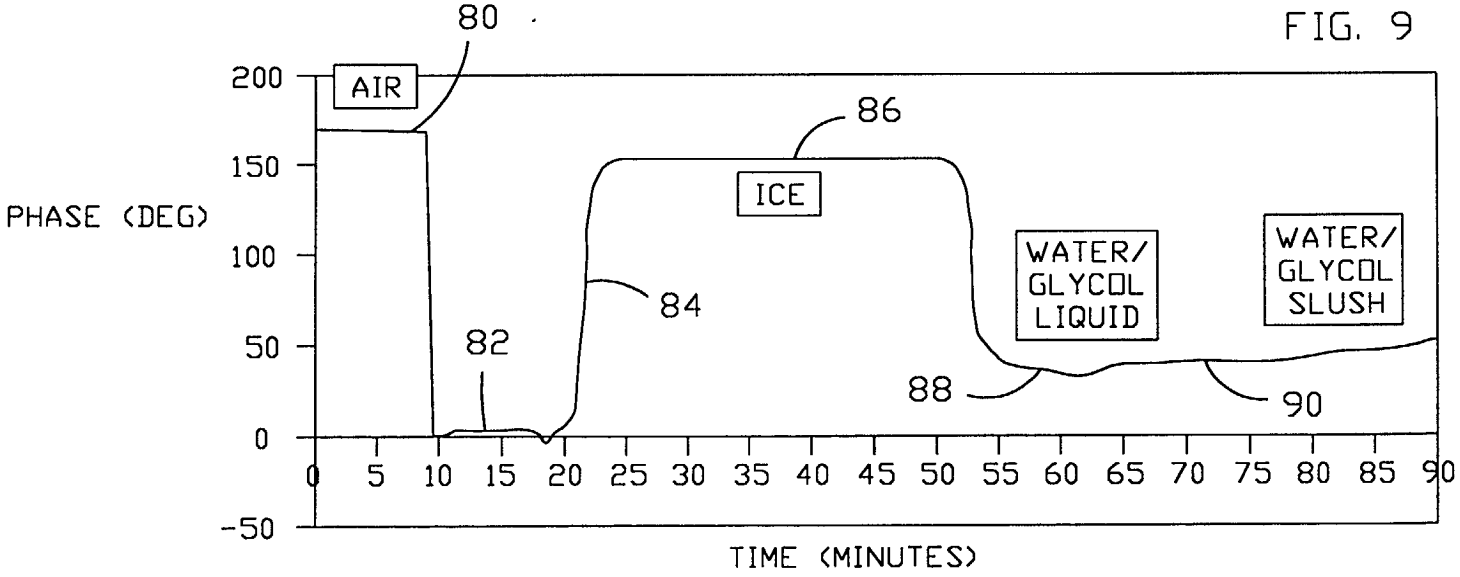

80
AIR
86
ICE
84
82
WATER/
GLYCOL
LIQUID
WATER/
GLYCOL
SLUSH
88
90
PHASE (DEG)
200
150
100
50
0
-50
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
TIME (MINUTES)

FIG. 10

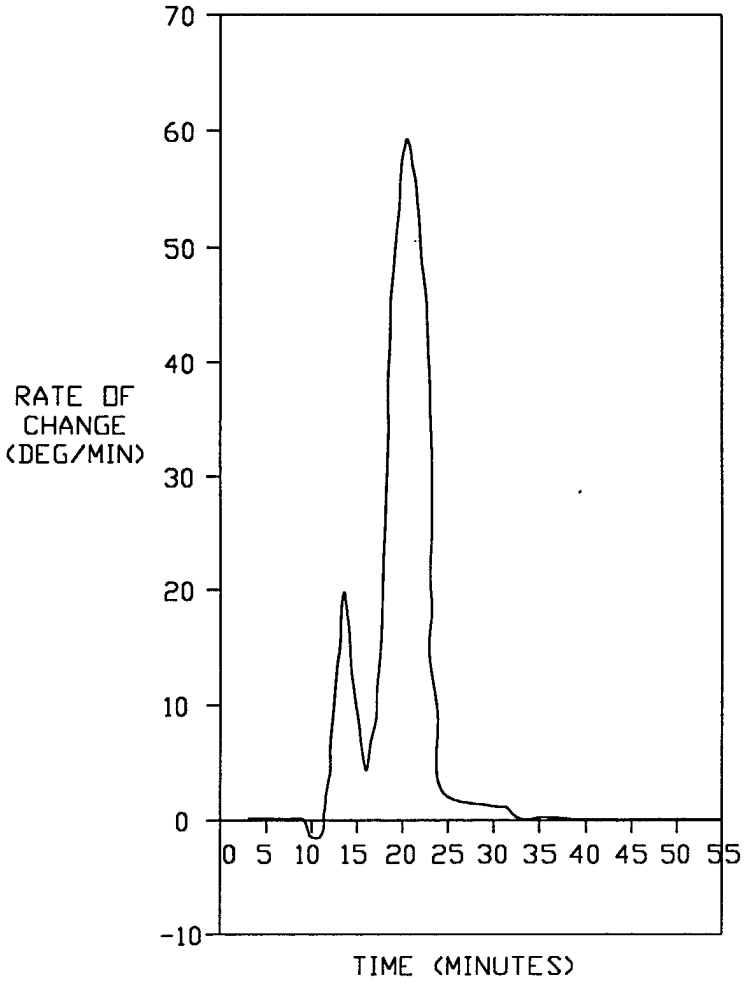
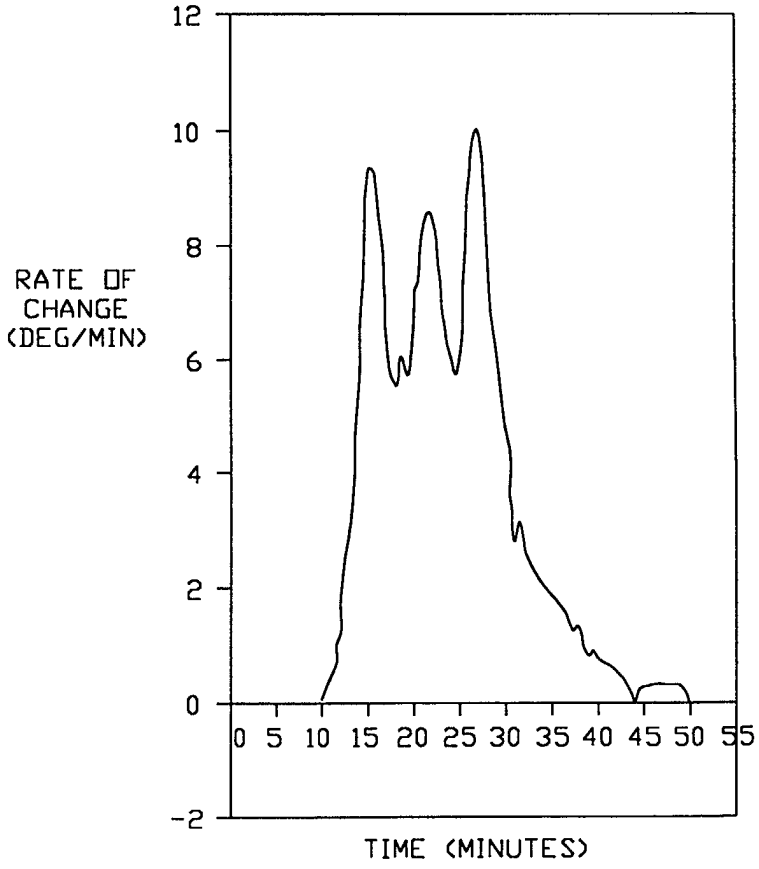

70
60
50
40
30
20
10
0
-10
RATE OF CHANGE (DEG/MIN)
0 5 10 15 20 25 30 35 40 45 50 55
TIME (MINUTES)

FIG. 11


12
10
8
6
4
2
0
-2
RATE OF CHANGE (DEG/MIN)
0 5 10 15 20 25 30 35 40 45 50 55
TIME (MINUTES)

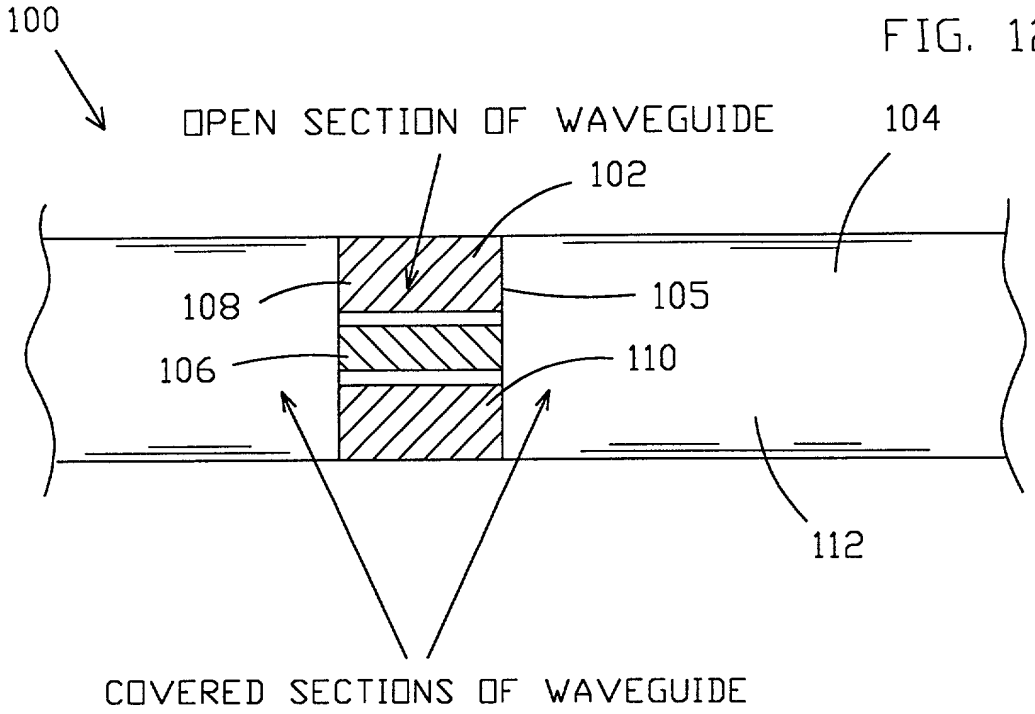


FIG. 12

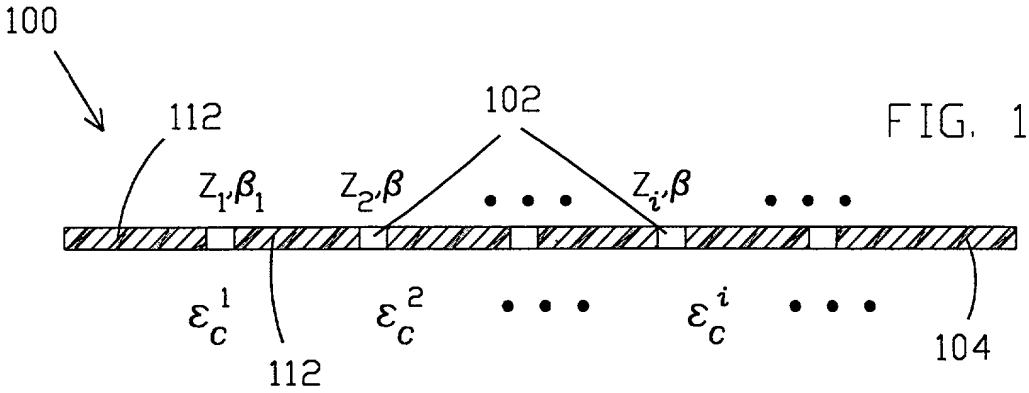


FIG. 13

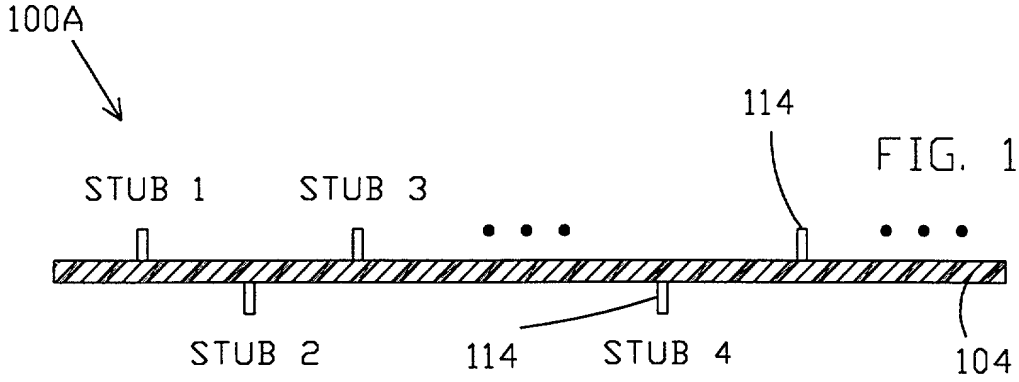


FIG. 14

FIG. 15

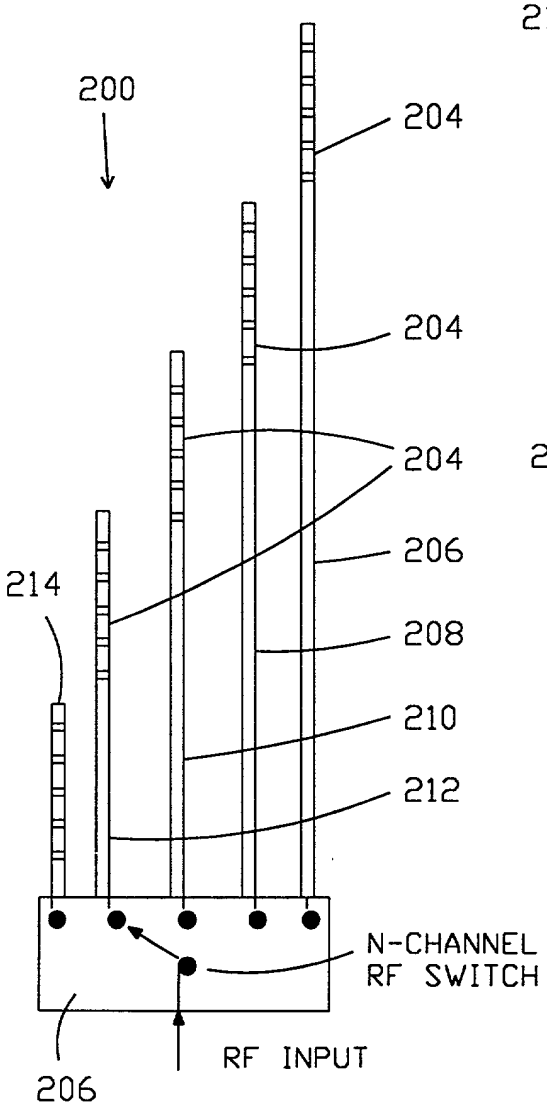

200
204
204
204
206
208
210
212
214
N-CHANNEL
RF SWITCH
RF INPUT
206

FIG. 16

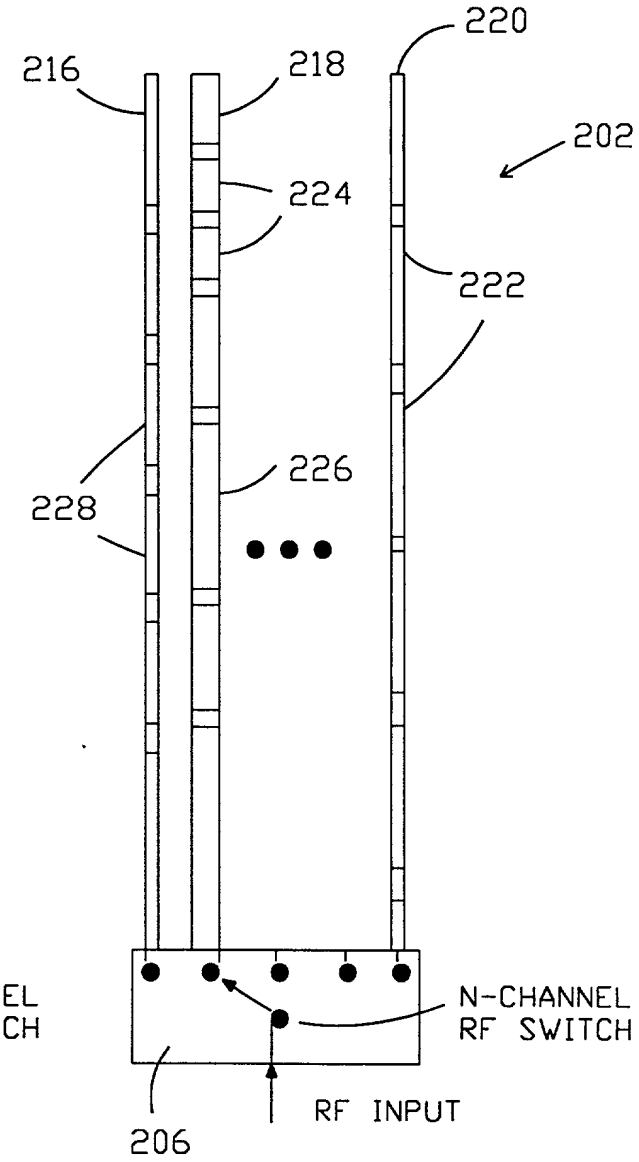

220
216
218
202
224
222
226
228
N-CHANNEL
RF SWITCH
RF INPUT
206

FIG. 17

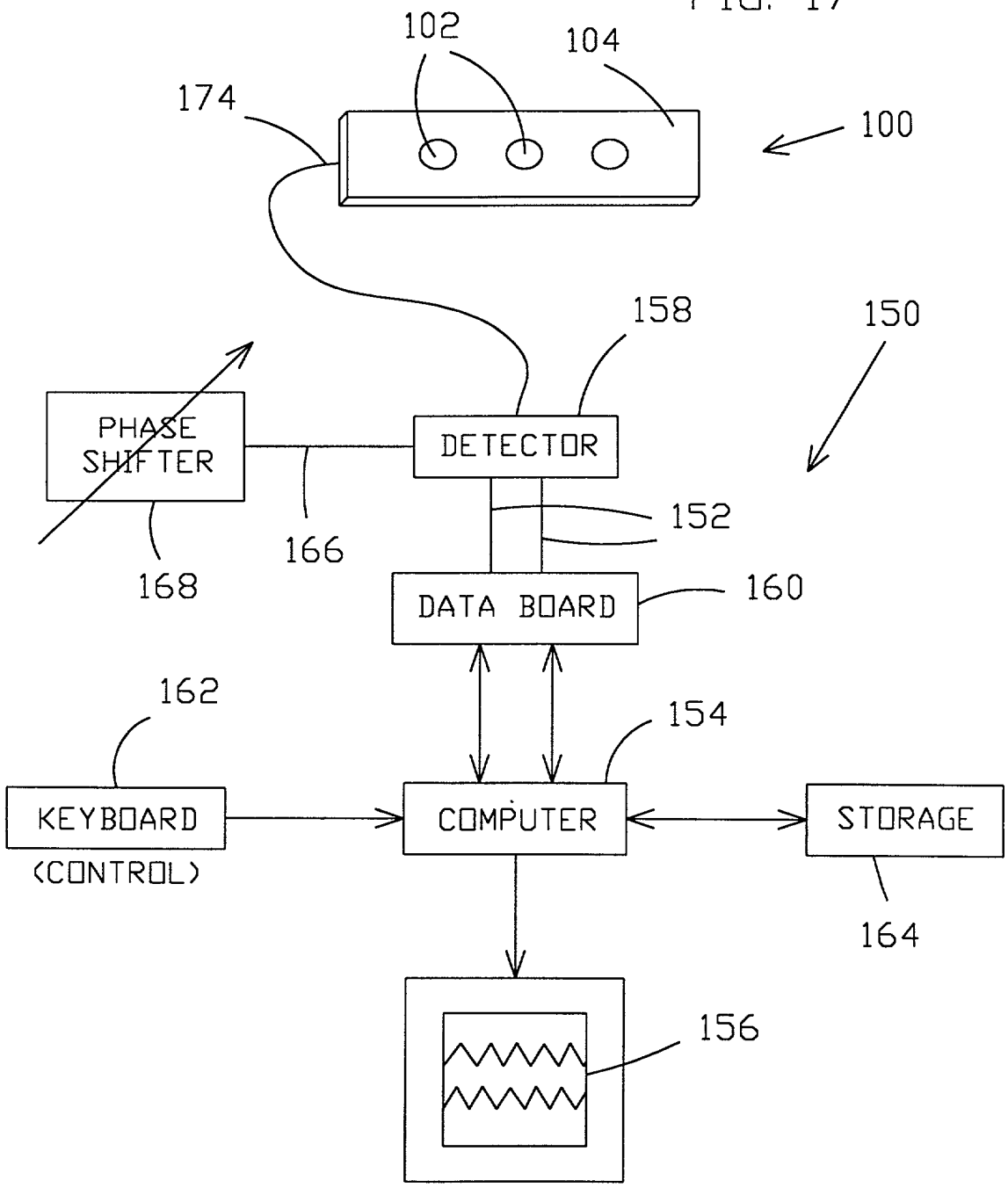
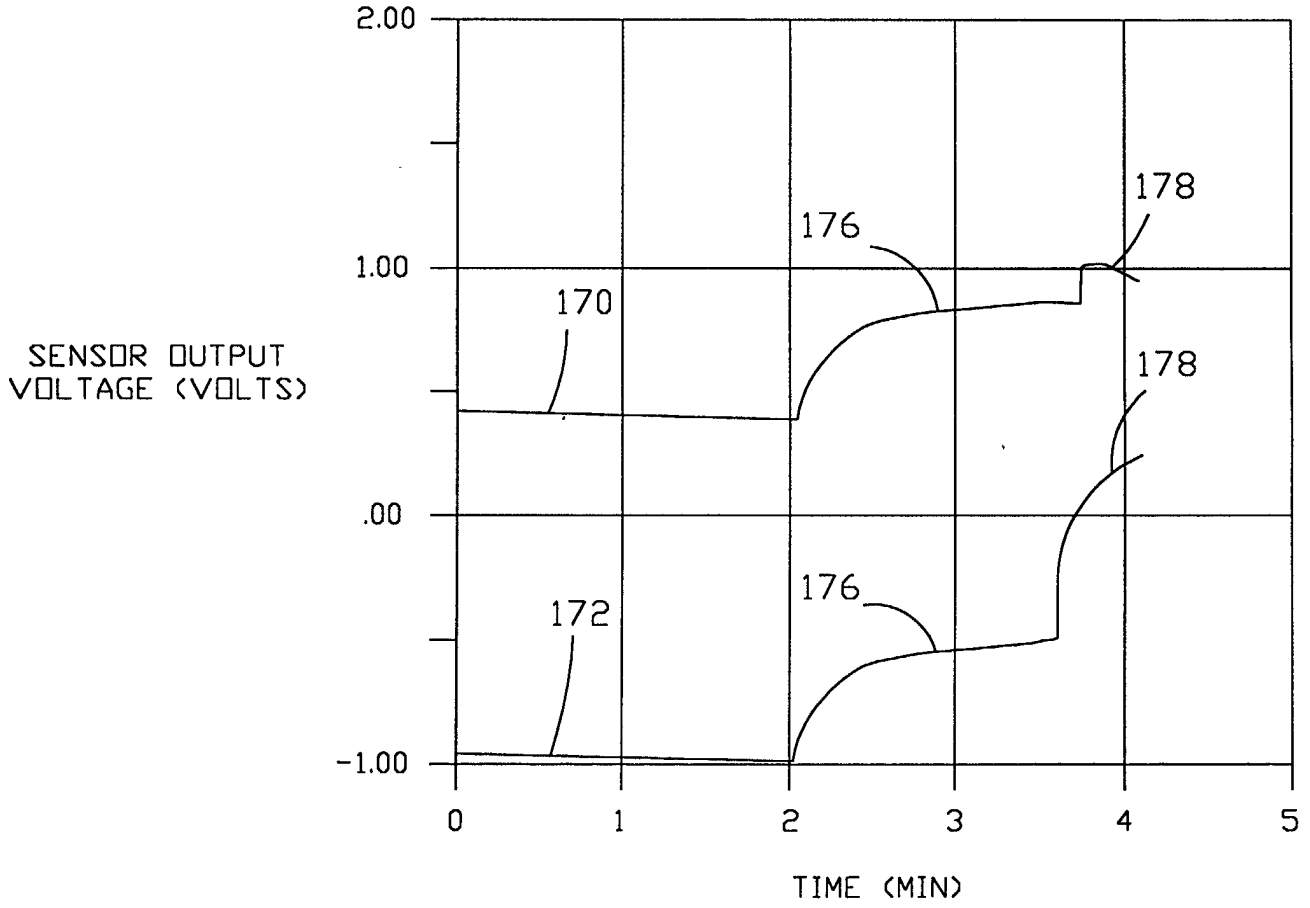

102
104
174
100
158
150
PHASE SHIFTER
DETECTOR
152
166
168
DATA BOARD
160
162
154
KEYBOARD
(CONTROL)
COMPUTER
STORAGE
164
156

FIG. 18


2.00
1.00
.00
-1.00
SENSOR OUTPUT
VOLTAGE (VOLTS)
170
172
176
176
178
178
0
1
2
3
4
5
TIME (MIN)